

## Study of Reservoir Quality in the upper Khami Formations in Mahshahr No.1 and Hendijan No.6 Wells

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**Abstract.** Khami group with thickness more than 1500 meter, in Dezful Embayment separated from Bangestan group by Kazhdomi shale formation. Dezful Embayment is an structural reality in the southwest of Zagros mountains range, that it contain almost of Irans oil fields. The upper Khami group make up carbonate formations Such as : Fahliyan, Gadvan and Dariyan with Aptian- Neocomian age. The Hendijan Field is located in the north of Persian gulf near beach. Mahshahr anticline is located in the north border of Persian gulf in the northern Dezful. In this study used information of petrology, formation temperature and characteristics of drilling fluids, such as : resistance of formation water and mud filtrate. Investigation of changes in porosity, shale volume and water saturation of Dariyan formation in two reservoir of Hendijan and Mahshahr shows, Dariyan formation in Hendijan well have better quality than Dariyan formation in Mahshahr well because of less shale and water saturation. With comparison of these parameters, we can conclude that the Khalij member of Gadvan formation in Hendijan reservoir have better reservoir quality than Mahshahr reservoir due to high porosity and less shale and water saturation. Regarding to low porosity of Fahliyan formation in both of reservoir and high shale volume and water saturation, there is not quality differences between Hendijan and Mahshahr reservoirs.

**Keywords:** Reservoir Quality, Water Saturation, Porosity, Shale Volume

### 1. Introduction

Because there is giant oil and gas basins, Zagros is considered as one of the most important petroleum basins in the world. The absent of igneous activities, existence of excellent source rocks with rich organic matter, porous reservoir rocks with variable permeability and appropriate cap rocks provide ideal conditions for accumulation and production hydrocarbons. It is caused Zagros zone considered as one of the biggest oil and gas province in the world [1]. Because of these problems, many drilling isn't done in Khami group of Dezful Embayment. Hence our information about each of petroleum reservoirs isn't more of several wells data [2].

Khami group is divided to five formations, contain of : Surmeh, Hith, Fahliyan, Gadvan and Dariyan. Surmeh and Hith belong to late Jurassic and Fahliyan, Gadvan and Dariyan belong to early cretaceous. Yet, more of observation on Khami group, are include stratigraphy, sedimentology, sedimentary environments and microfacies studies are done by various researchers inside and outside of Iran, but, in relation to interpretation of logging charts and quality evaluation of reservoir aren't done any studies in these formations specially two told reservoirs [3].

### 2. Materials and Methods

#### 2.1. Studying area

Dezful Embayment is a structural reality in the southeast of Zagros thrust that it include majority of Iran oil and gas fields. Generally, Dezful Embayment belong to part of Zagros that, Asmari is without outcrop

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there. Dezful Embayment is located between three important structural zones, it restricted in the north to flexure zone of Baba Rood with east – west trend, and in the northeast limit to Jebhe Kohestan flexure with northwest – southeast trend, and in the east – southeast limit to a complex flexure zone and southern fault with north – south strike.

Hendijan field is located in the northern part of Persian gulf and near beach. Distance of 6-Hendijan well until Hendijan city is about 16/5 kilometers. Mahshahr anticline is located in the northern border of Persian gulf in the region of northern Dezful. Hendijan anticline is located in the east and Tango anticline is located in the north – northwest of Mahshahr [4]. Mahshahr anticline strike is north-northwest to south-southeast [5].

## **2.2. Studying of formations in the region**

**Dariyan formation:** Its name get from Dariyan village situated in the south of type section. This formation had been call Orbitoline limestone, Albian – Aptian limestone and it has consider as Khami group, too. Type section of Dariyan carbonate formation has been measure in Gadvan mountain, exactly in the north of Dariyan village [6]. In this area, Dariyan carbonate formation has been changed to Garoo shale facies. This unconformity disappeared to middle Fars and Dezful embayment side. This formation change to garu formation in the southwest of Lorestan. In coastal Fars and Khuzestan province, there are observation that show unconformity in the upper layers of this formation (top of Dariyan formation) [7].

**Gadvan formation:** The type section of this formation has been chose in the eastern of Gadvan mountain that is located in 39 kilometer east – northeast of Shiraz. The lower part of this formation with Fahliyan formation is concordant and traditional. Gadvan formation is located in depth of 4512-4391 meters of Mahshahr well, and contain alternation of gray – brown argillaceous – Silty limestone and dark gray shale [8]. Gadvan formation is located in depth of 3423-3545 meters of Hendijan well and it has been made of soft gray marls and sometimes calcareous, and gray to light gray claystones.

**Fahliyan formation:** The type section of this formation located in southern side of Dal mountain, near Fahliyan village and in 20 kilometers east – southeast of Gachsaran city in Fars region. Fahliyan formation include 365 meter of brown to gray massive limestone. This formation is located in depth of 2012 – 4512 meters Mahshahr well and its thickness is about 500 meters [9]. Chiefly, it contain clay limestone, compact, hard and cream limestone and sometimes Stylolite limestone. This formation has most distribution in Fars province, but it observe in the north east of Dezful Embayment and in Lorestan province, too. Fahliyan formation laterally change to shale and clay limestones of Garu formation in the central region of Lorestan and Dezful Embayment. These changes are gradual and interfingering. Fahliyan formation separate from Surmeh formation by Hith Anhydrite in the border of Fars province.

## **2.3. Research method**

Carbonate reservoirs have high heterogenesis, common type of these rocks product 25-30 percent of oil in place by ordinary recovery methods. One of methods of the reservoir evaluation is use of petrophysical features and well logging. Logging charts provide essential information for quantity evaluation of Hydrocarbon, rock type and fluid characterisations inside them, too. Running logs in the well, have information that determine reservoir features, indirectly. Remarkably, information get from logs help to recognition of the reservoirs pay zones. Thickness and depth of them, determine of oil, water and gas in the formation and estimate of hydrocarbon reserves. Because petrophysical features of formation aren't directly measurable, thus, they must be concluded by other parameters of reservoir rocks such as : electrical resistance, density, sound transmit time, Radioactive and amount of Hydrogen [10]. Therefore study of stratigraphy, sedimentology and petrophysical evaluation of these reservoirs is very important for recognition of region with the best reservoir quality in the Embayment of the northern Dezful. Some of this aims has been done in this research.

Goal of this research is survey of logging charts in the 1. Mahshahr well and the 6. Hendijan well for determination of reservoir features of the formation such as: porosity, permeability, shale volume and etc [11].

### **2.3.1. Calculation methods of parameters and data analysis**

### 2.3.1.1. Resistance of formation water ( $R_w$ )

[1]. calculation of ( $R_w$ ) by special chart (schlumberger Gen-9 )that in this chart, formation temperature is located against formation salinity and ( $R_w$ ) is calculated.

[2]. We can determine ( $R_{wa}$ ) in the clean zones and saturated of water, then consider the least quantities as ( $R_w$ ).

### 2.3.1.2. Calculation of formation real resistance ( $R_t$ )

Formation real resistance is related to uninvasion zone. Resistance logs with high survey depth measure this resistance. With having measured resistances in various depths of the formation contain : ( $R_{xo}$ )=(resistance of flushed zone ), ( $R_{ils}$ )=(total resistance and of invaded and transition zone) and ( $R_{IID}$ )=(total of invaded, transition and flushed zone resistance), we can get ( $R_t$ ) by several ways [12,13]:

### 2.3.1.3. Calculation of porosity

Porosity is the percent of void volume ratio to total volume ( $\phi = v_p / v_t$ ) and it may create two forms : primary and secondary porosity (Table 1&2).

The porosity is without dimension and express with percent. In order to calculation of porosity is used porosity logs like : Neutron, Density, Sonic and usually by one or two log.

Microscopy studies shows all types of porosity in Hendijan and Mahshahr reservoirs ( Fig. 1, 2,).

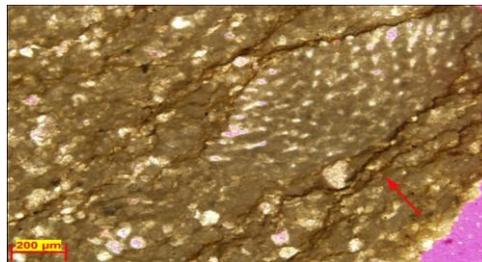


Fig. 1: Stylolith porosity

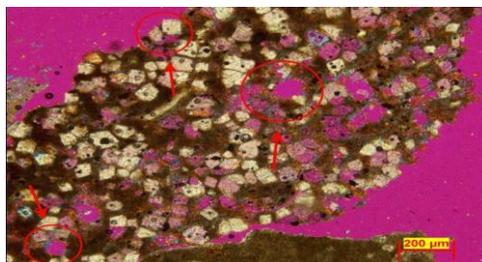


Fig. 2: Intercrystalline porosity

### 2.3.1.4. Shale volume

Table 1: Relation between bulk volume water and porosity types.

bulk volume water (BVW)	Carbonates
0/015-0/005	Vug
0/025-0/015	Vug and Intercrystallin (Intergranular)
0/04-0/025	Intercrystallin (Intergranular)
>0/05BVW	Chalk

The existence of shale in Hydrocarbon reservoirs, has much effect on estimation of reserve and production ability. Shales do not have constant mineralogy but clay mineral, quartz, feldspar, carbonates, amorphous silica, pyroclastic and organic matter are major constituents. Calculation of the shale volume from logging data for exact estimate of porosity and saturation is necessity. If influence of the shale volume

don't survey in the formation, visible influence will have on the results of water saturation, permeability and porosity of the reservoir [14].

Table 2: Relation between bulk volume water and decrease particle size.

bulk volume water (BVW)	Particle size (milimeter)
0/02 - 0/025	Coarse 1 - 5
0/025 - 0/035	medium 0/5 - 0/25
0/035 - 0/05	Fine 0/25 - 0/125
0/05 - 0/07	Very fine 0/125-0/0625
0/07 - 0/09	Silt <0/0625

### 2.3.1.5. Determination of lithology by use of logs

One of the important usage of logs is determine of lithology. Lithology features, that influence on logs, are mineralogy, texture, structure, shale bulk, fluids content. For determine of lithology, the best spot is place, that have the least shale bulk and porosity and is saturated of water. It cause Hydrocarbon affect on logs response get minimum [15].

## 3. Discussion and Inclusion

By study of changes amplitude, in Dariyan formation in two reservoirs, we can consider 10% porosity as weak porosity in Dariyan formation. Other aspect is shale bulk that respectively, shale content is 12% and 23% is Hendijan and Mahshahr in Dariyan formation, thus the content of shale bulk in Dariyan formation of Hendijan is lesser than Dariyan formation of Mahshahr. Content of saturation is 59% and 72% in two reservoir of Hendijan and Mahshahr, respectively, that it shows less water saturation content of Dariyan formation in Hendijan reservoir. Thus with compare this of 3 parameters, can consider Dariyan formation in Hendijan well have more quality than Dariyan formation in Mahshahr well. Comparison of Gadvan formation (Khalij member) in Mahshahr 1 and Hendijan 6 reservoir[16]:

By study of changes amplitude in Fahliyan formation in Mahshahr and Hendijan reservoirs, that they respectively, have 7% and 6% porosity and it consider a weak porosity. respectively, shale average is 11% and 18% in Mahshahr and Hendijan reservoirs. Thus shale average is low in both reservoirs. Thus with comparison of these parameters conclude quality is equal at two reservoirs.

1. Respectively, Dariyan, Gadvan and Fahliyan formation have been separated to 9,10,15 zones in Hendijan reservoir. 2. Respectively, Dariyan, Gadvan and Fahliyan formation have been separated to 12,7,13 zones in Mahshahr reservoir.

Analysis of well logging data shows porosity is weak in Dariyan and Fahliyan formation and shale content is low. Because sonic chart just measure background porosity and Neutron and density charts calculate total porosity of rock, sonic chart hasn't been considered in calculations.

Khalij member of Gadvan formation in Hendijan reservoir with porosity content equals 26% and saturation equals 41% and shale volume equals 3% has more reservoir quality than the Khalij member of Gadvan formation in Mahshahr reservoirs.

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